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COMMENTS ON THE CAINOZOIC HISTORY OF WESTERN TASMANIA

By

B. SCOTT

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ABSTRACT

A series of unconsolidated sands and gravels, with bands of clay and lignite, extends from Strahan and Malanna southwards to the Wanderer River, covering an area of approximately 225 square miles. Fossil determinations on two carbonaceous horizons at Strahan indicate an Upper Cainozoic age (probably Pliocene) for these deposits. Sections in cliff exposures on the eastern shore of Macquarie Harbour combined with the results of drilling by the Tasmanian Department of Mines show a minimum thickness of 730 feet, of which approximately 560 feet is below the present sea level. These beds are believed to have been deposited during the Upper Cainozoic in a graben. Continued movement on the boundary faults during deposition is indicated and the cyclic nature of the sedimentation could be related to this feature. Movement on these faults after deposition (post-Pliocene) is indicated by the presence of sediments at an elevation of 1,000 to 1,200 feet above the present sea level.

INTRODUCTION

During the regional mapping campaign of S.W. Tasmania recently carried out by personnel of Lyell-E.Z. Explorations (the exploration branch of Mt. Lyell Mining and Railway Co. Ltd. and the Electrolytic Zinc Co. of Australasia Limited), a series of unconsolidated sands and gravels, with bands of clay and lignite, was found to extend from Strahan (Figure 1) and southwards to cover an area of approximately 225 square miles. The sediments were demonstrated to be masking areas which would contain rocks belonging to the Dundas Group and Owen Conglomerate, of Lower Palaeozoic age. As these older rocks form the host for many of the sulphide deposits which are found on the West Coast, such as at Rosebery and Queenstown, it became necessary to examine these younger rocks in some detail in order to understand their broad outlines of lithology and thickness. As this work progressed, a study was also made of the various levels, or surfaces, to be seen within, and beyond, these unconsolidated sediments.

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Figure 1 : Location Plan of area described.

PREVIOUS WORK

The first observations relating to these sediments were made by Lempriere (1954) who was Commissariat Officer for the period 1835-1839 on the convict settlement which had been established on Settlement Island in Macquarie Harbour. His observations relate to the poor nature of the soil in the area, and the lignite at Coal Head. Later workers in C. Gould (1862), R. M. Johnston (1888, 1890, p. 53, 1894 p. 73), T. B. Moore (1894 p. 147, 1895 p. 56 and 62), A. Montgomery (1894, p. 167), C. L. Hills (1914), S. W. Carey (1950) and J. Bradley (1954, p. 193) make reference to these sediments on the east shore of the Harbour. Hills refers to a thickness of about 100 feet of horizontal beds of clays, sandstones, mudstones and lignites at Kelly Basin, in the S.E. corner of the Harbour. Further to the north, A. Montgomery (1890, p. 42), R. M. Johnston (1892, p. 11), J. W. Gregory (1904 p. 37) noted the presence of clays and lignites in the lower Henty River area and David (1926, p. 91) records the presence of lignitic shales and sandstone from the same area. Most recently, Banks and Ahmad (1959, p. 117) have presented a detailed account of the lithology and structure of these sediments in the Henty area. South of Macquarie Harbour the only reference to these sediments is by F. Blake (1936) in his report on the Wanderer River area.

During the last two summers sections were measured by R. G. Elms at Conder River (Locality L) and Moore's Valley (Locality M, Figure 2), by P. Rodda at the Spero River and Moore's Valley, and by B. Scott elsewhere. Apart from these localised studies work of a general nature was carried out by way of helicopter reconnaissance and the examination of aerial photographs.

DEPOSITS

It will be convenient to describe the deposits exposed from Macquarie Harbour southwards to Moore's Valley. To arrive at some overall coverage a description of the Cainozoic sediments at the Lower Henty River is also included. The description is from the recent paper by Banks and Ahmad (1959).

1. *LOWER HENTY AREA ; Section from Govt. Railway cuttings between Malanna and the Henty River* (Locality A on Fig. 2).

"The Cainozoic deposits exposed in the railway cuttings consist of more or less unconsolidated rocks, with gravels, cross bedded sands, clays and lignites being represented. The gravels are commonly bedded and the boulders in them are mainly sub-rounded. No striated pebbles were found although they were looked for. The rock fragments consist mainly of Permian sandstone, siltstone or granule conglomerate, dolerite, Owen Conglomerate, quartz and quartzite and more rarely fragments of clay or clayey sand or lignite. Some of these boulders are now deeply weathered." "It is also significant that the rock types present are all potentially of local derivation and could all come from within three miles to the east. The matrix of the gravels is predominantly sandy and they contain little clay."

2. *MACQUARIE HARBOUR* (Localities B to G on Figure 2).

The Cainozoic sediments are well exposed in the cliffs of the N.E. shore of Macquarie Harbour. These unconsolidated sediments form cliffs up to 200 ft. high and were graphically described by Moore (1894) as forming "a formidable wall of consolidated sand and mud."

In contrast to the sediments to the south of the Harbour, these sections contain two distinct sedimentary types, one distinguished by a predominance of sands and gravels (arenaceous) and the other by a predominance of shales and mudstones with thin bands of low rank coal (lutaceous). Analyses of these coals, and associated pyritic mudstones are shown in Table I. The lutaceous type is exposed in the cliff sections at Braddon Cliff (E) and Coal Head (D). Above and below these sections a regional dip of 5° to 10° to the N.W. exposes arenaceous sediments at Sophia Bay (B) and Neilson's Cliff (C) and Farm Cove (F) and Clarks Bay (G) respectively. These sediments are identical in most respects to the lignitic clay/sand/gravel noted south of Macquarie Harbour but with a maximum size range of only up to the cobble gravel grade.[1] Particles of Owen Conglomerate and Precambrian siliceous sediments (quartz-mica schists and metaquartzite) predominate but north of Coal Head, that is in the upper group of arenaceous beds, particles of granite and rocks of the Dundas Group are relatively common. The colour of these sediments varies from cream to yellow, some of those iron stained sands containing sufficient iron hydroxides to form a cement. The particles are generally rounded ; current bedding and gullying are common, with angular unconformities of up to 25 degrees. The current bedding direction varies from horizon to horizon in the sequence, and suggests both northerly and southerly current directions. The upper arenaceous beds are exposed at Neilson's Cliff (C) in a section showing 90 feet of sand and gravel, the low cliffs in Sophia Bay (B) show the same type of sedimentation, as do the sections at Strahan. The lower arenaceous beds are exposed in the cliff at Clarks Bay and show 75 feet of sand/gravel, at Farm Cove a cliff 54 feet high shows an identical sequence but with a 4 feet band of lignitic shale interbedded in the sand.

The lutaceous beds consist essentially of a thickness of sands and brown shales with minor clay bands. Lignitic bands are relatively common and thin seams of low grade coal and pyritic mudstones are also conspicuous (Table I). The sections at Braddon Cliff (E) (see Table II) and Coal Head (D), which are 2½ miles apart, appear to correlate reasonably well but between them at Philip Island and on the shore immediately to the north-east, the proportion of sand is higher than that at Localities E and D. Assuming that the shale beds were once continuous between Braddon Cliff and Coal Head, this emplacement of the arenaceous lens may well represent erosion, and later infilling, by an old river course. An example of this type of structure in the upper arenaceous beds can be seen at Sophia Bay.

The top of the lutaceous beds is present in the cliff near Coal Head (D). Its contact with overlying arenaceous beds appears to be conformable via a transitional unit 38 feet thick consisting of rapidly alternating layers of sand and brown shale/lignitic shale, each layer less than one inch in thickness.

1. Grain sizes follow Pettijohn (1957), p. 20.

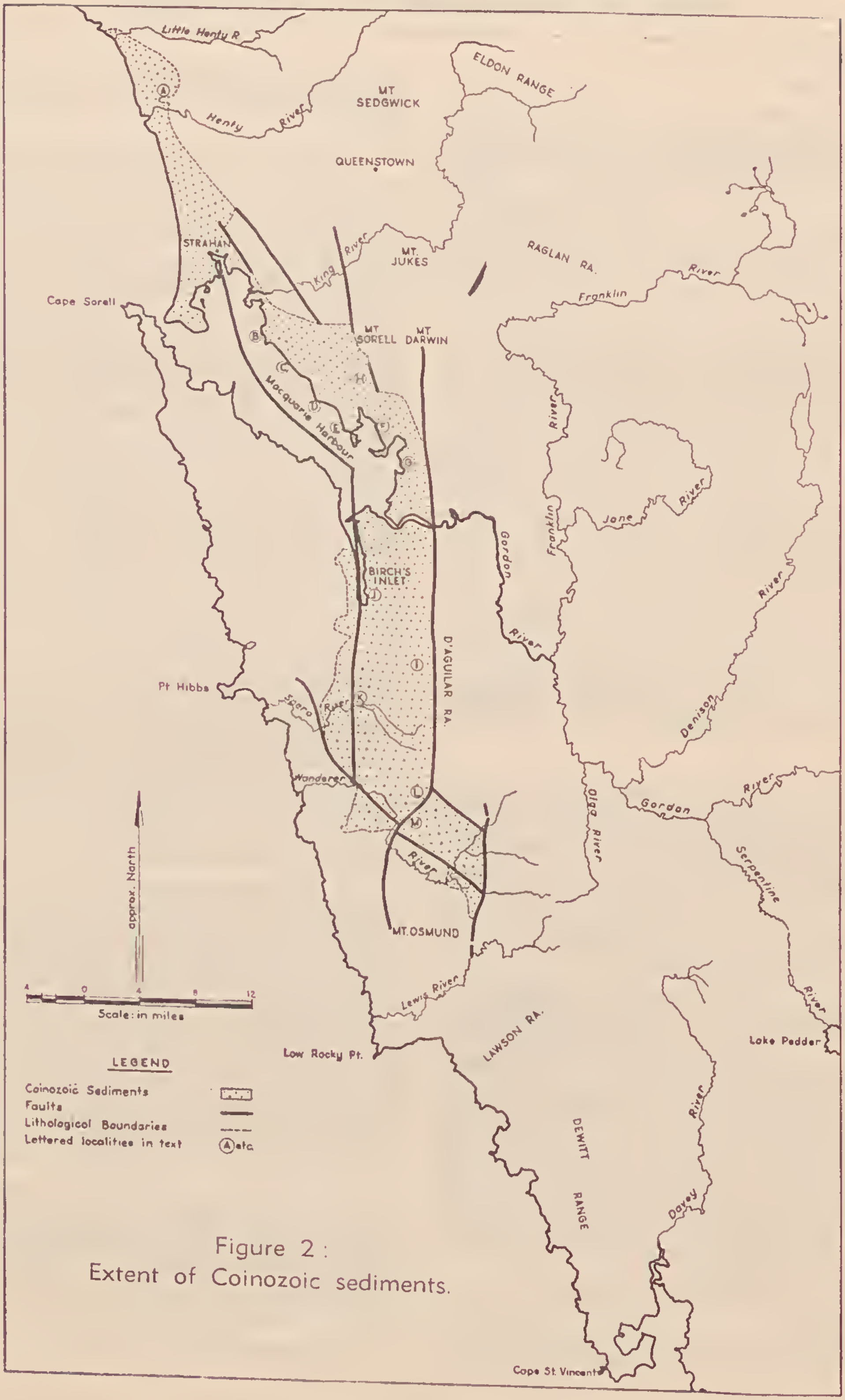


Figure 2:
Extent of Cainozoic sediments.

TABLE I

ANALYSIS OF COAL AND PYRITIC MUDSTONE FROM CAINOZOIC SEDIMENTS—MACQUARIE HARBOUR.

	1	2	3	4	5	6	7
Moisture	9.40	7.7	7.76	8.29			
Fixed Carbon	33.96	20.89	33.08	29.31			
Volatile	38.39	23.63	43.85	35.29			
Ash	19.06	48.33	15.87	27.75			
Total Iron					26.11	27.54	26.82
Ferrous Iron					18.26	18.97	18.61
Sulphur					7.20	4.50	5.85

Spem. 1 Coal from Braddon Cliff (Locality E)
2 Coal from Coal Head (Locality D)
3 Coal from Philip Island
4 Average of Spems. 1 to 3
5 Pyritic mudstone from Coal Head (Locality D)
6 Pyritic mudstone from Coal Head (Locality D)
7 Average of Spems. 5 and 6.

Analyses by Assay Office, Mt. Lyell Mining & Railway Co. Limited, Queenstown, Tasmania.

TABLE II

SECTION IN CAINOZOIC SEDIMENTS AT BRADDON CLIFF, MACQUARIE HARBOUR

		Lutaceous Type
Approx. 43 ft. to *TOP OF CLIFF*	5′	sand
	12′	brown shale becoming darker to top, pyritic at top
	½′	coal
	8′	brown shale with thin lignitic partings
	1′	pyritic mudstone
	2′	brown sandy shale
	7′	brown shale with thin (¼″) coal partings
	½′	coal
	3′	brown shale
Spem. 1 in Table II	3′	coal
	1′	pyritic mudstone
	2′	brown shale
	1′	light grey clay
BOTTOM	BEACH LEVEL	

TABLE III

FARM COVE BORE, MACQUARIE HARBOUR (Locality E on Figure 2)

Commenced 11th November, 1902 Completed 23rd January, 1903

Total Depth 571 feet

0′ - 33′ 10″	Alternating bands of lignite and clay none of the bands of lignite over twelve inches. No bands of lignite below 18′ 1″	Lutaceous beds
33′ 10″ - 88′ 3″	Alternating bands of grey, dark and light shales/sandy shales	Lutaceous beds
88′ 3″ - 180′ 10″	Sandstone, light and dark, very soft and friable	Arenaceous beds
180′ 10″ - 571′ 0″	Sandstones (soft and friable) with occasional lignite bands up to 5″ thick.	Arenaceous beds

Reference : Report Sec. Mines, Tasmania, 1902-1903, p. lvii.

Thickness of Cainozoic Sediments on Macquarie Harbour

Neither the base nor the top of the sequence has been seen. As has already been stated, the top of the lutaceous beds has been seen at Coal Head, with a measured thickness of 71 feet. Using these measured sequences the following thicknesses are obtained :

Measured Thickness of Cainozoic Sediments—Macquarie Harbour

Northwest—Top

Upper arenaceous group		
	At least 90 feet	Neilson's Cliff (C)
Lutaceous group	71 feet	Coal Head (D)
Lower arenaceous group	78 feet	Clarks Bay (G)

Southwest—Bottom

A vertical bore drilled by the Tasmanian Department of Mines is summarised in Table III. The exact location of the collar is not known but from the description it would have been in the near vicinity of Braddon Cliff (E). Assuming a regional dip of 5° to the northwest and that the hole stayed vertical, the base of the lutaceous beds was located at a depth of 87 feet, after which the hole continued in 481 feet of the lower arenaceous beds. Using this result with that of the field observations, the minimum thickness of the lutaceous beds can be taken as 158 feet.

Minimum Thickness of Cainozoic Sediments—Macquarie Harbour

Northwest—Top

Upper arenaceous group	90 feet
Lutaceous group	158 feet
Lower arenaceous group	481 feet
	730 feet (to nearest 10 ft.)

It is interesting to note that of this thickness of 730 feet, approximately 560 feet is below the present sea level.

3. *EASTERN MARGIN — D'AGUILAR RANGE AND MT. SORELL* (Localities I and H).

The sediments immediately to the west of these two localities are poorly exposed and there has not been the opportunity for the measurement of a section.

Lithologically, the sediments are boulder gravels with particles of Owen Conglomerate up to 3 to 4 feet in size, in an unconsolidated matrix of sand. Structurally, these friable sediments are faulted against the Owen Conglomerate to the east, a rock noted for its hardness and durability. However, the Cainozoic sediments near the D'Aguilar Range form a prominent cliff 100 to 200 feet higher than the flat Henty surface which has been cut into the western flank of the mounain range here (see Figure 3). This cliff and associated surface, which is also present at the south end of Mt. Sorell is rapidly being removed by erosion.

4. *BIRCH INLET* (Locality J).

The sediments at the south end of Birch Inlet consist of pebble/cobble gravels and sands. Particles of the Owen Conglomerate and Precambrian are common, but sandstone pebbles derived from the Eldon Group also occur. Particles of the Dundas Group are not apparent.

5. *SPERO RIVER* (Locality K).

The sediments contain a similar series of gravels, sands and clays as seen elsewhere in the area, with a maximum range into the boulder grade (+10″). Again the particles are predominantly siliceous and consist of Owen Conglomerate and Precambrian metaquartzites and quartz-mica schists. The measured sequences show a rapid variation in character as they are traced northwards from the Spero River. This change is expressed in the wedging out to the north of the sand grade and a concomitant increase in the gravel. Westwards there appears to be a reverse in this trend. Two other examples of this rapid horizontal variation in the character of the sediments here are the appearance of a band of lignitic clay 4 feet thick over two sections 70 yards apart and the thickening of a sand unit from 12 inches to double this thickness with a 3″ band of pebble gravel over two sections six feet apart. All units show marked current bedding and gullying, with angular unconformities of up to 13 degrees.

These observations all reflect unsettled conditions of deposition and it is considered that this may be due to movement, during deposition, on the western boundary fault of the basin of accumulation (Figure 2) which is placed as only approximately 900 yards west of this locality. Immediately to the west of this boundary, the base of the Cainozoic sequence, resting on the Dundas Group, can be seen in the Spero River. This base is several hundred feet above sea-level.

6. *CONDER RIVER* (Locality L).

The generalised sequence at the Conder River has been built up from a study of three sections. The succession resembles that seen elsewhere, sands, pebble and cobble gravels consisting of particles of Precambrian metaquartzites and quartz-mica schist and of Owen Conglomerate. Particles of chert and shale also occasionally occur.

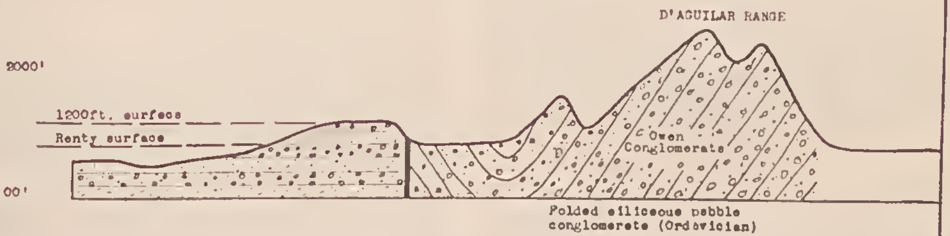
The column of 248 feet can be broadly divided into 5 stages, of which only the middle three are fully represented. Each stage is characterised by a decrease in grain size from bottom to top, from cobble and pebble gravels (plus 2″) to pebble gravels (less than 2″) and sands. There is also some evidence to suggest that the degree of sorting improves with decreasing grain size. Banks and Ahmad (1959, p. 123) noted a similar change in grain size in the Malanna area.

7. *MOORE'S VALLEY* (Locality M).

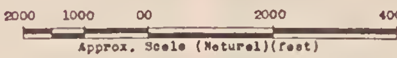
The generalised sequence here has been built up from a study of three different sections. The succession is similar to those already described and consists of a series of sands, pebble and cobble gravels with lignitic clay bands which dip 5° to 10° to the north. In contrast, these sediments occasionally contain appreciable (up to 50%) quantities of detritus from the Dundas Group, particularly towards the base of the measured sequence. Otherwise the particles consist of Owen Conglomerate, quartz-mica schist and metaquartzite. Usually the gravels have a sand matrix with less amounts of clay particles. However, occasionally the matrix is mainly clay.

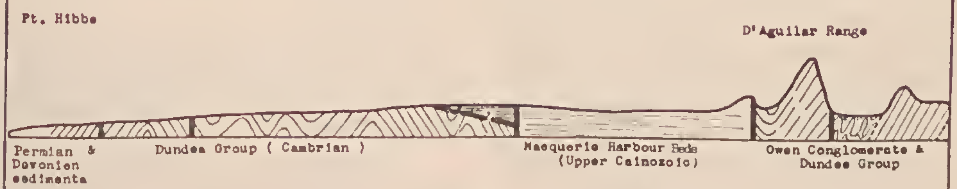
FIG. 3

DIAGRAMATIC SECTIONS
SHOWING RELATIONSHIP OF SURFACES
TO STRUCTURE AND LITHOLOGY

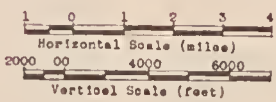


Section through locality 'I' on fig. 2
Looking North





Section Pt. Hibbs — locality 'I' on fig. 2



In one of the measured sequences of 235 feet, six cycles or parts of cycles, can be distinguished. A cycle typically follows the pattern already outlined at the Conder River locality except that the top unit is sometimes a thin band of lignitic clay up to 2 feet in thickness. A complete cycle would be about 40 feet thick.

An investigation of the detrital minerals in the sediments established the obvious abundance of quartz, with muscovite. Rutile, hematite, topaz, zircon, kyanite and biotite were also identified, magnetite and chromite were not seen.

A minimum thickness of 425 feet has been measured with an unknown thickness removed from the top and an unknown thickness below the base of the measured column. Geophysical results indicate a thickness of 300 to 400 feet below the present valley floor but this figure cannot be directly added to that of 425 feet. A minimum thickness of 600 to 700 feet is indicated, the base of which is at an elevation of approximately 100 feet below sea-level.

AGE OF DEPOSITS

Particles of Owen Conglomerate (Ordovician) are common throughout the sediments with particles of sandstones of the Eldon Group (Silurian) being less abundant. In the lower Henty River area, Gregory (1904) and Banks and Ahmad (1959) recorded the presence of particles of dolerite (lower Jurassic) and Permian sandstone and conglomerate. In 1892, Johnston recorded the presence of a *Fagus* close to F. *cunninghami* and an *Acacia* close to A. *melanoxylon* from the lignites of the latter area. From this same area, Banks and Ahmad (1959) report the presence of seeds and seed cases on cones of *Banksia marginata* which also bear a close resemblance to the seed cases of forms still living in the area. According to Banks and Ahmad (op. cit.) on this basis the beds in the lower Henty area would best be considered as Upper Cainozoic.

E. D. Gill (personal communication, 1959) collected specimens from two carbonaceous horizons which are present in the cliff near the Customs House at Strahan. The fossil determinations were the work of Dr. Isabel Cookson and her colleagues of the National Museum of Victoria. Near the road level there is a carbonaceous horizon containing *Triorites harrisii*, *Nothofagus* (abundant), *Dacrydium* ; *Acacia*, grasses and herbs are present. About fifty feet above this is another carbonaceous horizon containing *Triorites harrisii* (not abundant), *Dacrydium* (more abundant), *Acacia*, herbs and grasses are present. The lower horizon is considered to be Tertiary in age. In view of the similar ecology, and the site being the same, it is probably significant that *Acacia*, grasses and herbs are absent although present at the higher level. This higher band is Pliocene or Quaternary in age. *Acacia* is not known in beds older than Pliocene, the herbs and grasses are indicative of an Upper Cainozoic age. Considering the fossils, the stratification, and the ecology, Gill places the more likely age as Pliocene.

In summary at least the upper part of the sediments in the Strahan area and northwards to the Henty River can be considered as being Upper Cainozoic in age, probably belonging to the Pliocene Epoch. These sediments have in the past been called Macquarie Harbour Leaf Beds (Johnston, 1890), Macquarie Harbour Group (Carey, 1950), Macquarie Beds (Bradley, 1954) and Macquarie Harbour Beds (Banks and Ahmad, 1959). It is suggested that the term Macquarie Harbour Beds is retained and it be defined as that group of unconsolidated sands and gravels with shale and lignite bands uncomfortably overlying the Dundas and Junee Groups. It is several hundred feet thick and Upper Cainozoic in age, probably Pliocene. It is named after Macquarie Harbour on the west coast of Tasmania where the type area occurs. The co-ordinates in this area are (Zone 7 Grid) 810,000N, 340,000E (Strahan) for the unconsolidated sands and gravels and 788,000N, 351,000E for the shales and lignite (Braddon Cliff).

BASIN OF DEPOSITION

Figure 2 shows that the borders of the Macquarie Basin[1] are primarily limited by fault planes. Those to the east and north-east are readily apparent, those to the south are based on geological and geophysical evidence but the western boundary fault running through Birch Inlet is primarily located on the results of an airborne magnetic survey. The boundary to the north-west is now covered by Macquarie Harbour but the lack of correlation between the geological features on either side of the Harbour strongly suggests the presence of a substantial fault running through this area. Some information as to its more precise location can perhaps be arrived at by contouring the soundings in the Harbour[2]. The isobaths show that the bottom of the Harbour is 'V' shaped with the depth of plus 90 feet located in its centre and running north-westerly, towards Sophia Point (Locality B on Figure 2), and then north-north-westerly towards Strahan ; this is the trace marked on Figure 2 as the location of the boundary fault here. The vertical throw on these boundary faults is not known although it must obviously have been considerable. One of these faults near Strahan brings the Dundas Group (Upper and Middle Cambrian) against quartzites of the Eldon Group (Silurian) but a reasonable estimate based on stratigraphic thicknesses involved is not possible owing to the possible wedging out of sediments (particularly the Owen Conglomerate of Ordovician age) in this area. However, a conservative estimate would be several hundred feet, possibly over a thousand feet.

It is interesting to note that all of the rock types present in the Cainozoic sediments could be of local derivation, within a few miles of the edge of the basin of deposition. Banks and Ahmad (1959) noted the same relationship in the northern area at Malanna.

The abundance of particles of Precambrian and Owen Conglomerate (Ordovician) and the comparative absence of particles of the Dundas Group (Cambrian) can be explained in two premises. Firstly, on the

1. The term Macquarie Basin is used as a general term to signify the general locality of deposition.
2. It is interesting to note from these isobaths that a relative drop in the water level of 25 feet would isolate the Harbour from the Ocean and deplete its extent by approximately 25%. A relative drop of 100 feet would reduce the Harbour into two small, shallow (20-70 ft. deep) isolated lakes.

relative durability of each type, with the lavas and shales etc. of the latter Group rapidly breaking up on weathering and transportation, and secondly on the assumption that the land to the east of the basin was higher than that to the west and that, as a consequence, most of the debris for sedimentation came from the former direction. As the stratigraphy to the east is primarily of Precambrian and Owen Conglomerate rocks, the absence of particles belonging to the Dundas Group is not surprising. The particles of granite which occur in the sediments on the north-east shore of the Harbour were presumably derived from the Darwin granite which occurs some eight miles to the east at Mt. Darwin (Figure 2), unless some unknown and nearer source is being masked by the Cainozoic sediments themselves. The kyanite which was noted in the sediments of Moore's Valley presents an interesting problem in that if it were derived from the Precambrian terrain to the east its occurrence indicates a higher metamorphic grade than the garnet mica schists which are known to occur in this area. However, kyanite has only been noted as a detrital mineral and has not yet been seen *in situ*.

SUMMARY

In summary then, these late Cainozoic sediments are believed to have been deposited into a fault basin, resembling a rift valley. The thickness of these sediments on the north-east shore of Macquarie Harbour is at least 730 feet, 560 of which is below the present sea-level. At Moore's Valley, there is good evidence for a similar minimum thickness but only with approximately 100 feet of these sediments below the present sea-level. At neither of these localities has the top of the Cainozoic sediments been recognised and, once inside the graben, only at Moore's Valley (and this is on the basis of apparent resistivity surveys) is there a definite suggestion of the base of these sediments.

Continued movement on the boundary faults during deposition is suggested and the unsettled conditions of deposition at the Spero River locality which is close to the western boundary fault appear to support this contention. The cyclic nature of the gravel/sand/lignitic clay could also be related to this movement. The presence of sediments of the Macquarie Harbour Beds 1000 to 1200 feet above the present sea-level indicates that there has been considerable tectonic activity in the Cainozoic, some at least in the Late Cainozoic.

From the descriptions given of the Cainozoic sediments, they are not a typically marine series and the presence of lignite/coal bands indicates that these bands at least can be ascribed to formation in a paludal environment. These Macquarie Harbour Beds more closely resemble the Tertiary sediments which occur near Launceston than any other sediments of comparable age in Tasmania. These latter sediments are described by Carey (1947, p. 31) who suggests that they were deposited in lakes. Gill and Banks (1956, p. 11) indicate that at least part of these sediments are of Eocene/Lower Oligocene age. Elsewhere in Tasmania Banks (1957, p. 78) presents a summary of the Tertiary formations in the N.W. and N. of the island. Marine limestones of Upper Oligocene/Lower Miocene age are recorded in the N.W. and at Cape Barren Island (Furneaux Group). No further marine sediments are known until those deposited at Cape Barren Island of Upper Pliocene/Pleistocene age. Banks relates this cycle of events to an Upper Oligocene/Lower Miocene marine regression and then a re-advance of the sea in the Pliocene Epoch which affected only the Furneaux Group of islands. Consequently it would appear that whilst marine sediments were being deposited at the latter locality sediments were being deposited in the Macquarie Basin in what would appear to be a large lake. When it is considered that the Basin now borders the open ocean it is difficult to visualise what prevented a marine invasion into this area.

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